WHAT IS CLAIMED IS:

1. A modelocked fiber laser which outputs linearly polarized optical pulses, comprising:

a laser cavity, comprising:

a first length of polarization-maintaining fiber within said laser cavity; and

a non-polarization-maintaining fiber grating within said laser cavity and coupled to said first length of polarization-maintaining fiber, said non-polarization-maintaining fiber grating coupling said optical pulses out of said laser cavity; and

a second length of polarization-maintaining fiber which is outside of said laser cavity and which is coupled to receive said optical pulses from said non-polarization-maintaining fiber grating;

the polarization axes of said first and second lengths of polarization-maintaining fiber being aligned so that said output pulses coupled into said second length of polarization-maintaining fiber propagate predominantly in one of the linear polarization axes of said second length of polarization-maintaining fiber.

2. A modelocked fiber laser as defined in Claim 1, additionally comprising:

a passive modelocking element within said laser cavity.

3. A modelocked fiber laser as defined in Claim 1, wherein a dispersion value associated with said non-polarization-maintaining fiber grating largely matches the inverse of a dispersion value associated with the remainder of the elements in said cavity.

4. A modelocked fiber laser as defined in Claim 3, wherein the dispersion value associated with said non-polarization-maintaining fiber grating is positive and the dispersion value associated with the remainder of the elements in said cavity is negative.

5. A modelocked fiber laser as defined in Claim 3, wherein the dispersion value associated with said non-polarization-maintaining fiber grating is negative and the dispersion value associated with the remainder of the elements in said cavity is positive.

6. A modelocked fiber laser as defined in Claim 1, wherein said non-polarization-maintaining grating has a bandwidth greater than 10 nm.

7. A modelocked fiber laser as defined in Claim 1, wherein said non-polarization-maintaining grating has an absolute dispersion value less than $|0.5\ ps^2|$.

8. A modelocked fiber laser as defined in Claim 1, wherein said non-polarization-maintaining grating is apodized.

9. A modelocked fiber laser as defined in Claim 1, wherein said non-polarization-maintaining grating is an end-mirror for said laser cavity.

10. A modelocked fiber laser as defined in Claim 1, wherein said laser cavity additionally comprises a section of thermal-diffusion expanded core fiber.

11. A modelocked fiber laser as defined in Claim 10, wherein said section of thermal-diffusion expanded core fiber comprises an end that is angle-polished.

12. A modelocked fiber laser as defined in Claim 10, wherein said section of thermal-diffusion expanded core fiber has an expanded end, and wherein said laser cavity additionally comprises a saturable absorber closely coupled to said expanded end of said thermal-diffusion expanded core fiber.

13. A modelocked fiber laser as defined in Claim 12, wherein said expanded end of said thermal-diffusion expanded core fiber is coated with an anti-reflection coating.

14. A modelocked fiber laser as defined in Claim 1, wherein said laser cavity additionally comprises a saturable absorber.

15. A modelocked fiber laser as defined in Claim 14, wherein said saturable absorber comprises:

a layer of aluminum-free material having a pair of opposed surfaces; and

a reflective material disposed on one of said pair of opposed surfaces.

16. A modelocked fiber laser as defined in Claim 15, wherein said layer of aluminum-free material is between 50 and 2000 nanometers thick and has a wavelength bandedge of approximately 1 micrometer.

17. A modelocked fiber laser as defined in Claim 16, wherein said wavelength bandedge is between 1.0 and 1.6 micrometers.

18. A modelocked fiber laser as defined in Claim 15, wherein said reflective material comprises a dielectric mirror.

19. A modelocked fiber laser as defined in Claim 15, wherein said reflective material comprises gold or silver.

20. A modelocked fiber laser as defined in Claim 15, additionally comprising a heat sink disposed at a side of said reflective material opposite said layer of aluminum-free material.

21. A modelocked fiber laser as defined in Claim 20, wherein said heat sink comprises metal, diamond or sapphire.

22. A modelocked fiber laser as defined in Claim 20, wherein said heat sink comprises a metallic mirror.

23. A modelocked fiber laser as defined in Claim 15, additionally comprising a layer of anti-reflection material disposed on one of said pair of opposed surfaces of said layer of aluminum-free material.

24. A modelocked fiber laser as defined in Claim 15, wherein said layer of aluminum-free material comprises InGaAsP material.

25. A modelocked fiber laser as defined in Claim 1, additionally comprising:

a saturable absorber within said laser cavity, said saturable absorber comprising:

a plurality of multiple quantum well layers, and

a plurality of passive spacer layers each disposed between a respective pair of said multiple quantum well layers.

26. A modelocked fiber laser as defined in Claim 25, wherein the respective widths of two of said plurality of passive spacer layers that are adjacent to one of said multiple quantum well layers are different.

27. A modelocked fiber laser as defined in Claim 25, wherein one of said plurality of passive spacer layers is coated with an anti-reflection coating on a side thereof opposite from an adjacent multiple quantum well layer.

28. A modelocked fiber laser as defined in Claim 1, additionally comprising:

a gain fiber within said laser cavity; and

a pump coupled to energize said gain fiber.

29. A modelocked fiber laser as defined in Claim 28, wherein said gain fiber includes a V-groove, and wherein said pump laser is coupled to said V-groove.

30. A modelocked fiber laser as defined in Claim 28, additionally comprising:

a polarization maintaining wavelength division multiplexer coupler for coupling said pump laser to said gain fiber.

31. A modelocked fiber laser as defined in Claim 1, further comprising:

a nonlinear fiber coupled to said second length of polarization-maintaining fiber.

32. A modelocked fiber laser as defined in Claim 31, wherein said nonlinear fiber is selected from a group consisting of a dispersion flattened fiber, a dispersion flattened holy fiber, a negative dispersion fiber, and a positive dispersion fiber.

33. A modelocked fiber laser as defined in Claim 1, wherein said output pulses have spectral bandwidths exceeding 100 nm.

34. A fiber laser according to Claim 1, further comprising:

an ensemble of fibers of different dispersion characteristics as well as dispersion compensating elements for the generation of pulses with spectral bandwidths exceeding one octave.

35. A saturable absorber mirror for passive modelocking of lasers, comprising:

a film of a semiconductor material implanted with high energy ions at a penetration depth which differs from the penetration depth of optical signals reflected from said saturable absorber mirror.

36. A saturable absorber mirror as defined in Claim 35, wherein the thickness of said film is selected to be in the range of 50 nm – 2000 nm.

37. A saturable absorber mirror as defined in Claim 35, wherein said high energy ions comprise protons, arsenic or beryllium;

38. A saturable absorber mirror as defined in Claim 35, wherein the implantation dosage of said high energy ions is in a range $10^{12} - 10^{17}$ ions/cm^2.

39. A saturable absorber mirror as defined in Claim 35, wherein said high energy ions comprise protons and wherein the implantation energy of said high energy ions is in the range of 5 keV – 200 keV.

40. A saturable absorber mirror as defined in Claim 35, wherein said high energy ions comprise arsenic, and wherein the implantation energy is in the range of 100 keV – 1000 keV.

41. A saturable absorber mirror as defined in Claim 35, where one surface of said mirror is anti-reflection-coated.

42. A saturable absorber mirror as defined in Claim 35, wherein the thickness of said film controls the phase of the reflected light signal within opposite surfaces of said mirror.

43. A saturable absorber mirror as defined in Claim 35, wherein said semiconductor material exhibits multi-temporal relaxation under optical excitation with short optical pulses.

44. A saturable absorber mirror as defined in Claim 43, wherein a first relaxation time in said semiconductor film is less than 10 ps and a second relaxation time in said semiconductor film is greater than 100 ps.

45. A saturable absorber mirror as defined in Claim 35, wherein said semiconductor film comprises a bulk semiconductor.

46. A saturable absorber mirror as defined in Claim 35, wherein said semiconductor film comprises a multiple quantum well structure

47. A saturable absorber mirror as defined in Claim 35, wherein said semiconductor film comprises a combination of a bulk semiconductor and a multiple quantum well structure.

48. A saturable absorber mirror for passive modelocking of lasers, comprising:

a film of a semiconductor material implanted with high energy ions at a penetration depth which is smaller than the penetration depth of optical signals reflected from said saturable absorber mirror.

49. A saturable absorber to be operated in transmission for passive modelocking of lasers, comprising:

a film of a semiconductor material implanted with high energy ions at a penetration depth which is smaller than the thickness of said film..

50. A passively modelocked fiber laser cavity, comprising:

a saturable absorber within said fiber laser cavity which exhibits plural different temporal relaxation characteristics under excitation with short optical pulses; and

a fiber Bragg grating having dispersion characteristics which largely offset the dispersion characteristics of the remaining elements within said laser cavity.

51. A passively modelocked fiber laser cavity, comprising:

a fiber Bragg grating having dispersion characteristics which largely offset the dispersion characteristics of the remaining elements within said laser cavity.

52. A passively modelocked fiber laser cavity, as defined in Claim 51, wherein the dispersion characteristics of the fiber Bragg grating and the dispersion characteristics of the rest of the intra-cavity elements are matched to within a factor of three.

53. A passively modelocked fiber laser cavity, as defined in Claim 51, wherein the dispersion characteristics of the fiber Bragg grating and the dispersion characteristics of the rest of the intra-cavity elements are matched to within a factor of two.

54. A passively modelocked fiber laser cavity, as defined in Claim 51, wherein the dispersion characteristics of the fiber Bragg grating and the dispersion characteristics of the rest of the intra-cavity elements are matched to within a factor in the range of 1.0 to 2.0.

55. A passively modelocked fiber laser cavity, as defined in Claim 51, wherein the fiber Bragg grating has a chirp rate greater than 80 nm/cm.

56. A passively modelocked fiber laser cavity, as defined in Claim 51, wherein the fiber Bragg grating has a chirp rate greater than 160 nm/cm.

57. A passively modelocked fiber laser cavity, as defined in Claim 51, which produces optical pulses having pulse widths shorter than 200 fs.

58. A passively modelocked laser comprising a Bragg grating with a chirp rate greater than 300 nm/cm.

59. A modelocked fiber laser cavity, comprising:

a length of fiber within said cavity doped with material which provides gain;

a fiber grating within said laser cavity, said fiber grating having a dispersion value which is opposite in sign to the summed dispersion value associated with said length of doped fiber and all remaining elements within said cavity, said

fiber grating producing chirped pulses within said cavity which have a temporal width at least twice the pulse width corresponding to the bandwidth-limit of the pulse spectrum of the pulses oscillating inside the cavity.

60. A modelocked fiber laser cavity as defined in Claim 59, wherein the fibers within said cavity are predominantly polarization maintaining fibers, wherein the intra-cavity light oscillates in a linear polarization state within said polarization-maintaining fibers, and wherein said laser cavity has an output which is produced through a polarization-maintaining pigtail to produce a predominantly linear polarization state light output.

61. A source for optical coherence tomography, comprising:

a passively modelocked fiber laser cavity, comprising:

a fiber Bragg grating having dispersion characteristics which largely offset the dispersion characteristics of the remaining elements within said laser cavity.

62. A source for optical coherence tomography as defined in Claim 61, additionally comprising an ensemble of fibers of different dispersion characteristics for additional spectral broadening of the laser pulses.

63. A source for frequency metrology, comprising:

a passively modelocked fiber laser cavity, comprising:

a fiber Bragg grating having dispersion characteristics which largely offset the dispersion characteristics of the remaining elements within said laser cavity.

64. A source for frequency metrology as defined in Claim 63, additionally comprising an ensemble of fibers of different dispersion characteristics for additional spectral broadening of the laser pulses.

65. A saturable absorber for passive modelocking of lasers operating in the 1.0 – 1.1 um wavelength range , comprising::

a film of bulk InGaAsP fabricated with a bandgap in the 1.0 – 1.1 um wavelength region.